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VOL. IV. NEW YORK, AUGUST, 1899. No. 6

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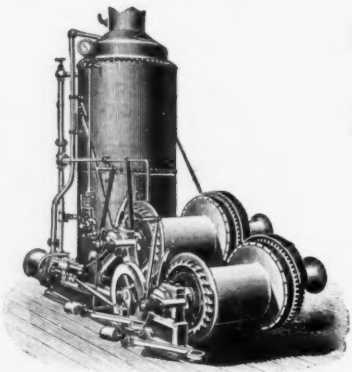

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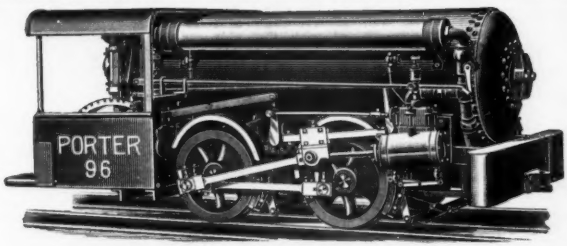

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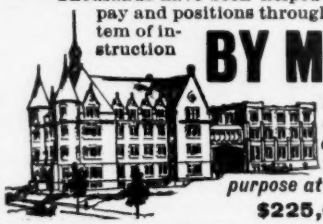

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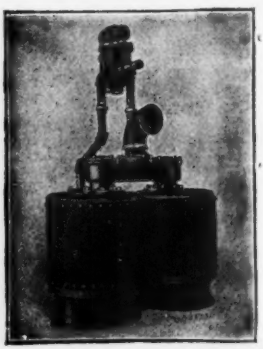

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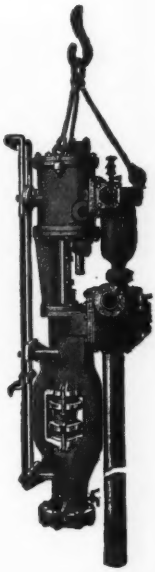

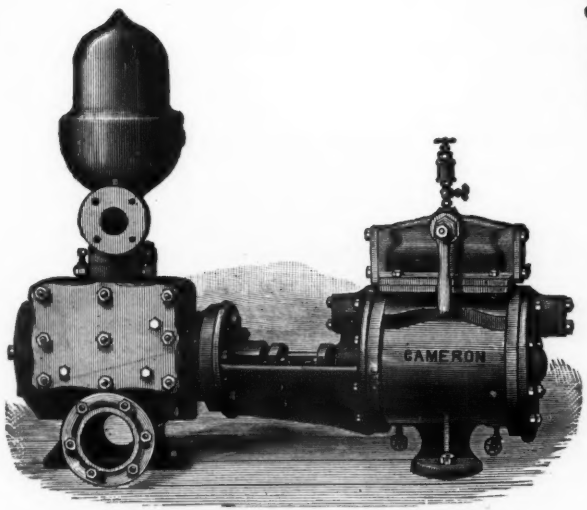

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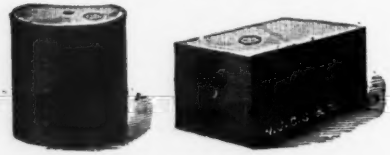

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A MONTHLY PUBLICATION DEVOTED TO THE USEFUL APPLICATION OF COMPRESSED AIR.

W. L. SAUNDERS, - - Editor and Proprietor
A. E. KENNEY, - - - - Managing Editor
J. E. QUINTERO, - - - - - - Associate

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The railroad men are at the fore front in compressed air development. The extraordinary interest shown in the exhibition of compressed air appliances at the Master Mechanics and Master Car Builders' Convention, at Old Point Comfort, held in June last, was indicative of the spirit that has taken possession of these practical men, and that their attention is directed toward air power means much that will be beneficial to these interests. No mechanical field possesses such a varied line of available applications. The subject is discussed with much fervor at the meetings of these associations, and their organization has made it possible for the exchange of ideas that are practical in every detail; many very useful appliances are suggested allowing a riotous utilization of the scrap heap, in the construction of home-made shop tools.

The use of air in railroad shops is augmented by the ubiquitous Pneumatic Tool man. He has been the missionary that plodded untiringly, and he has lived to see a demand for the various tools which he handles.

A notable example of this was shown in the exhibit of the pneumatic tool builders at the Old Point Comfort convention, for it is said that compressed air received more attention than any other subject, and that the interest far surpassed that of any previous year.

There are great improvements in the tools themselves, and they are becoming cheaper at the same time. They have been talked of so much that further description seems a waste of words, but such is not the case. People who are just investigating the merits of compressed air are glad to get hold of data relating to the use and economy of these appliances. What might seem a repetition in the mention of compressed air tools is rather the elaboration of well-known subjects for the benefit of the constantly increasing converts to compressed air practice.

An average temperature of the air of 54 degrees F. is best adapted to the public health, for at that temperature the decomposition of animal and vegetable matter is slight, and animal temperature is most easily maintained. Every degree of temperature above or below that point requires more or less of an effort of the heart-regulating power to maintain the proper equilibrium. Even more potent in elevating the bodily temperature is the introduction into the blood, whether by respiration or by direct injection of putrid fluids and the gases of decomposing matters. If this injection is repeated at short intervals, death will occur with a high temperature. The air of cities contains emanations, in hot weather, from a vast number of sources of animal and decomposition, and the inhalation of air so vitiated brings in contact with the blood these deleterious products in a highly-divided state, which cause a fatal elevation of temperature in the young, old and enfeebled. The same effect is produced by the air in close and heated places, as in tenement houses, work shops, school houses, hospital wards and other rooms where many persons congregate for hours.

Traction and Auto-Mobile

Popp Compressed Air Motors for Tramway Traction.

The installations transmitting power by means of compressed air from central stations to an aggregate of 8,000 horse-power for a great number of industries in operation in Paris, effect the transmission by means of canalisation, or miles of air mains laid in the streets, with branches leading into workshops and other places where required. The successful operation of this system, invented and carried out by M. Victor Popp, induced him also to extend it to the supply of compressed air for tramway traction.

It is impossible to better explain the position which compressed air as a motive power occupies than by quoting the report of Mr. Humblot, inspector general of the Department of Bridges and Roads of France. In effect, he says:

"Compressed Air is not a source of power. It is, in reality, only a vehicle for the transmission of power in heat, which heat can re-transform itself into power.

In order to obtain from air an economical return, it is necessary to supply it with caloric at the moment of its utilization, by re-heating, in order to compensate for the losses of every nature to which it has been subjected as a consequence of cooling after compression in the tubes and reservoirs.

By employing compressed air in traction, all the many advantages are secured which this agent has been demonstrated to possess in the mechanical applications which have heretofore been made.

If there is anywhere a demand for an easily manageable motor, it is certainly for tramways.

With compressed air, variations of speed are obtained with the greatest ease and without shock, by the simple turning of a cock; stops are made almost instantaneously, as vehicles operated by this system naturally employ air brakes, the reliability of which is so well known.

Owing to the Popp system of feeding points along the line, a single power station can supply several lines at the same time, becoming therefore a veritable central station for the entire network of tramways of a city, and at the same time distribute in a whole city mechanical energy as done now in Paris. The weight of the new Popp car, seating fifty persons, is 16,000 pounds when empty.

In order to gain a still higher economy, the motor is compound and the air is re-heated twice.

The motor being compound (or with two cylinders) can, according to its needs at various points of the route, work with either double or single expansion.

By means of a special regulating apparatus, the several combinations by which the compressed air is admitted into the motor cylinders, for starting, regulation of power and speed, stopping, and brakes, operate in a cycle perfectly established and controlled and with the greatest simplicity.

The various parts of the regulating apparatus are operated by a single handle and only require in consequence a single movement.

The entire mechanism is hidden beneath the car body. The body itself remains completely independent of the frame upon which it rests.

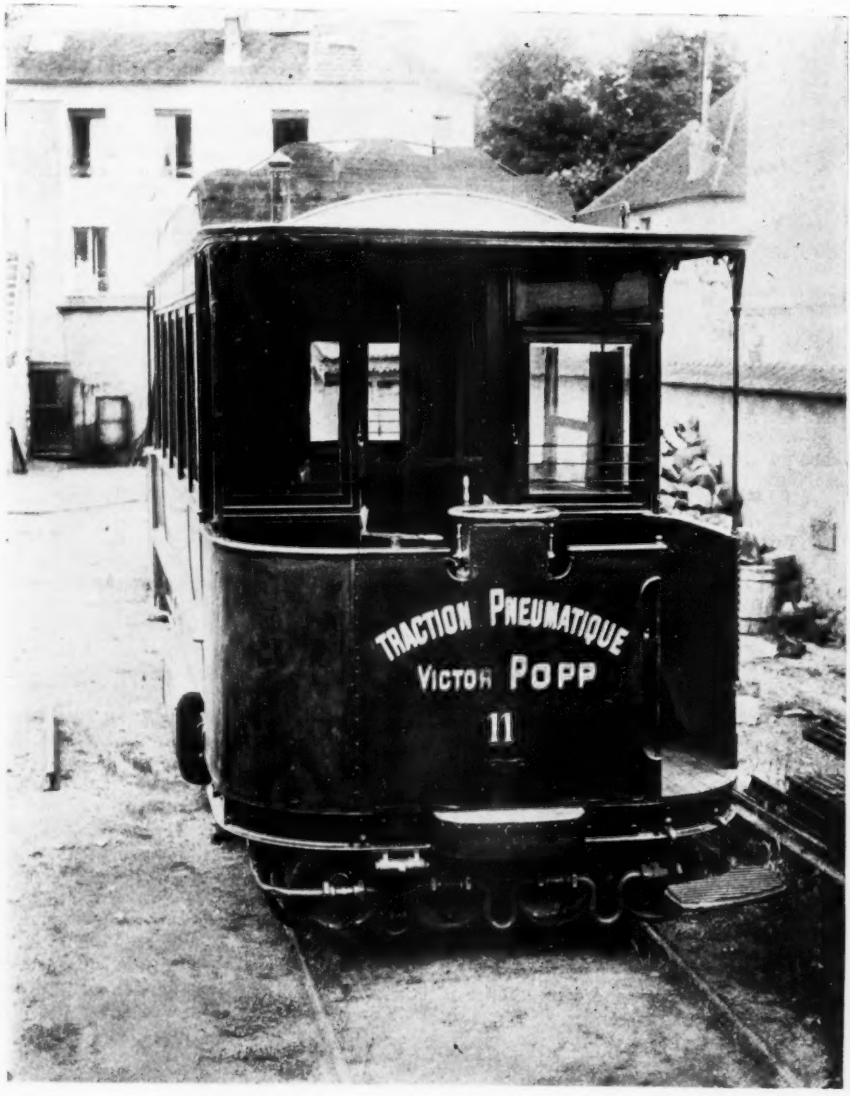
The platforms are entirely free.

The driver on the front platform has nothing whatever to do but to operate one controlling handle.

The car runs equally well in either direction. At a terminus the driver moves to the other platform, carrying with him the handle. The expense and inconvenience of turn-tables is thus avoided.

Motor Car.

The frame and springs have a very strong, solid, and well-built appearance, while the cylinders and all movable parts are inside, and placed between the wheels. The frame is suspended by leaf springs jointed to the axle boxes over the axle centres, while the body is suspended on leaf springs fixed to the end of the framework. This double suspension produces a gentle motion, and facilitates the pas-



A Compressed Air Car Used in Paris.
Popp System.

sage of the car round sharp curves, even in the case of long car bodies. The two axles are connected by connecting rods. One of the axles is worked directly from the compressed air cylinder by means of wheel gearing, consisting of two wheels. The larger wheel is fixed to the wheel axle, the smaller one to the motor shaft, showing the frames of the compressed air cylinders with their piston rods, crank shafts, and the slides with their eccentrics —in a word, the whole mechanism. The above-mentioned gearing runs in oil enclosed in an oil box. The frame is of solid cast steel. The compressed air engine is designed on the compound system with varying expansion. (Meyer.) An attempt has been made in designing the machinery to arrange the various parts so that they should be easily accessible for repairs and removal if necessary. As the engine is worked on the compound principle it is provided with two cylinders; and the compressed air is heated during expansion and before entering the cylinders by means of a coke fire laid on a hopper arrangement which is filled once a day. The compound motor can be worked at double expansion or with direct admission of the compressed air in both cylinders. By means of a special disposition of the slide valves the compressed air can be worked at different degrees of expansion, by its variable admission into the cylinders; whereby also the power of the engine, its speed, the stoppages, and operation of the brakes are perfectly regulated according to the requirements of the service. All these operations are carried out by means of the pair of levers at the driver's hands. As there are no heating vessels or any other machinery on the platform, these are perfectly free, and can be used for passengers—the carrying capacity of the motor car is, therefore, so much increased.

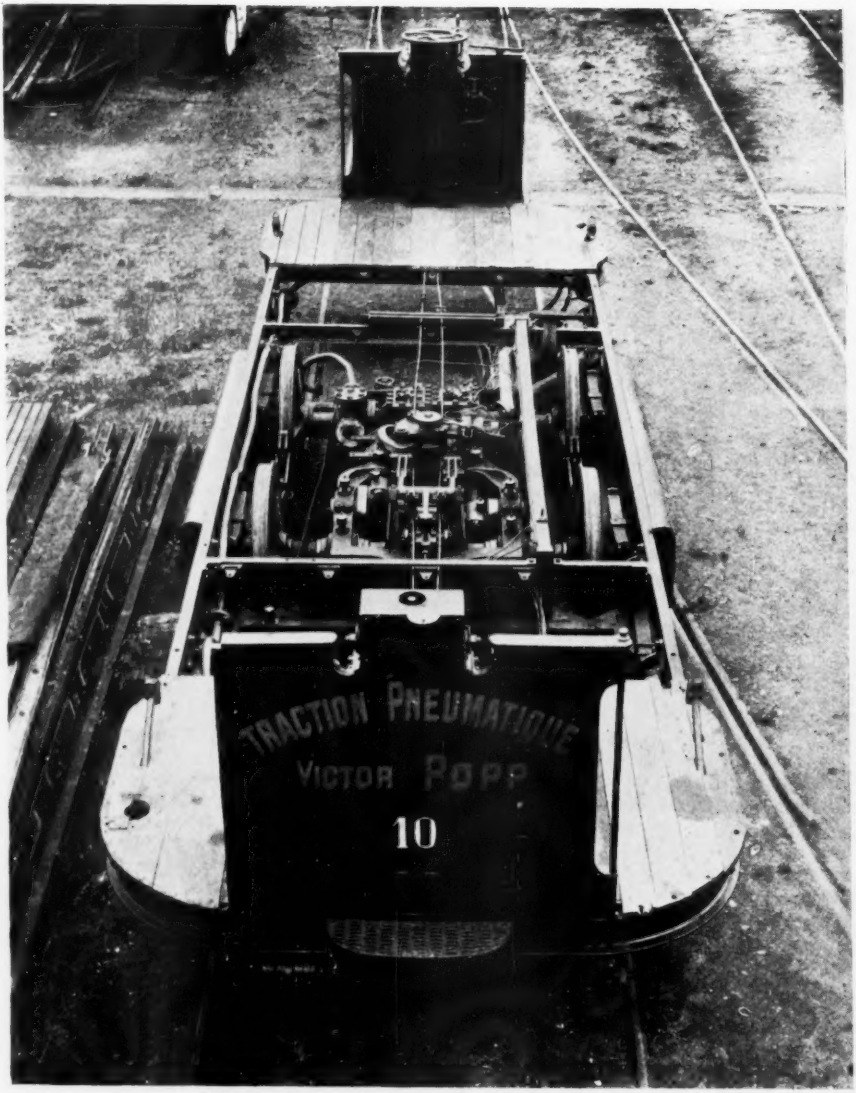
Air Reservoirs and Heater.

The air flasks are fixed under the platform (fore and aft) and are charged for the St. Maur lines at 700 lbs. pressure. The chargement is made in less than one minute by means of a pipe emerging from a post at one side. The driver, without having to leave his machine, makes a joint which, by means of a valve and a differential valve piston, establishing the connection between the air pipe and the car tanks. Soon as the full charge is taken in the driver shuts the admittance valve, cuts off the connection with the post and through the loss of pressure, the valves close the connection with the pipe and the car goes along without any loss of time. From the air reservoir the compressed air goes first through a pressure regulator, passed to the heater, then to the small cylinder returned to the heater and then to the large cylinder and last through the exhaust pipe. In the heater the air is each time heated to 200 C.

The Popp tramways carry compressed air flasks made of specially prepared steel under and, if necessary, on top of the carriage. The flasks have been made to withstand a pressure of 4,000 lbs. to the square inch. The maximum working pressure used for the cars in St. Maur is 700 lbs. The air for the cars is compressed by three 150 horse-power compressors. The storage capacity of the compressed air flasks on the Popp car with a maximum working pressure of 2,000 lbs. would be enough to run the car 36 to 40 miles.

Controlling the Car,

One of the features of the Popp car is the working of the motor and air brakes. All the required moves which can be asked from a street car are made instantly, as easily and without possibility of mistake on the part of the motorman as can be imagined. The car conductor has before him one wheel and two small handles immediately below. The use of the left handle is to reverse the motor movement. The right handle to open and cut off the air admission and commands also the safety brake. The wheel commands—1st, the air brake at variable pressure; 2d, the progressive admission to the small cylinder (high pressure); 3d, the direct admission to the small and to the large cylinder (low pressure). The various operations are made with one turn of the wheel. It will be remarked by this that whenever the motorman wants to use the brake before the brake came in use automatically the admission is entirely cut off both in using the safety and variable brake through the handle or the wheel. Outside of these two brakes the Popp car is furnished with an ordinary hand brake.

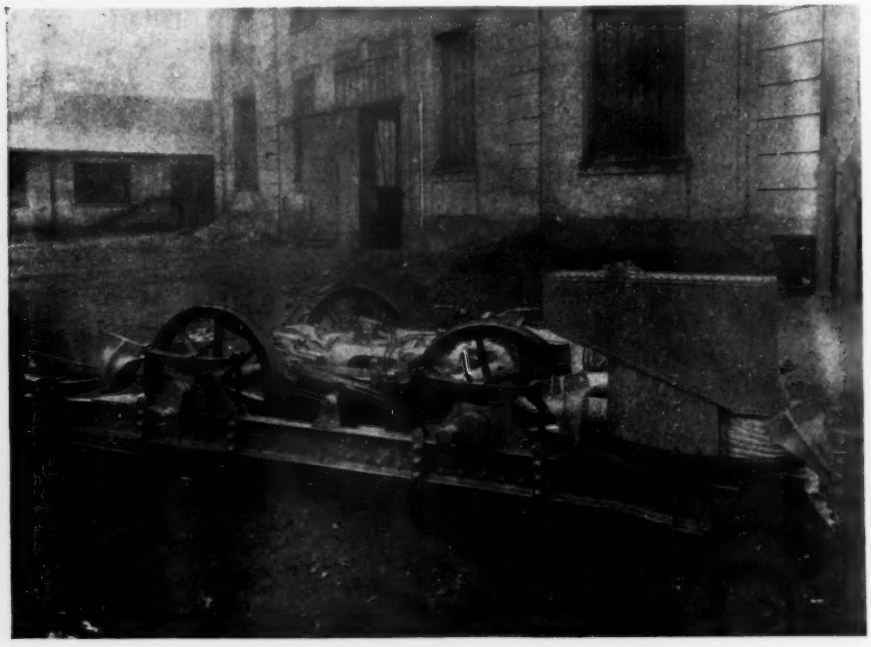


MECHANICAL TRUCK AND FRAME READY TO RECEIVE THE CAR BODY.
THE POPP SYSTEM.

Traction and Consumption of Air.

The motor is capable of slipping the wheels on a dry rail under weight of 36,000 lbs. The air consumption of the car running on the Saint Maur les Fossees (Seine) lines (3% ascent) varies from 25 to 35 lbs. per mile. The car runs 10 miles at a speed from 12 to 20 miles an hour.

in the Popp car, the air being re-heated before its admission to the cylinder to a temperature of 200 C., involved losses in the pipes, small escapes such as may happen in the mechanism, and also cost of operating the wheel brakes, is 30.577 lbs. in compressed air reducing to atmospheric pressure. One steam horse-power-hour at the station where the air



SIDE VIEW OF MOTOR AND TRUCK.
THE POPP SYSTEM.

Cost of Production of Compressed Air and Its Utilization as a Motive Power for Tramways.

The cost per horse-power-hour in compressed air reduced to atmospheric pressure and utilized by motors of from 15 to 50 effective horse-power, has been established by numerous trials in Paris. Motors of the above power are principally employed in mechanical traction for tramways. The consumption of air in a compound motor such as is employed

is compressed at a pressure of 853 lbs. equals 11 lbs. air reduced to atmospheric pressure. For reheating the air per mile car, 0.50 lbs. coke.

Conclusions.

It is clear that system of mechanical traction for tramways will have chances of adoption proportionate to its gain in economy of operation; reduction in expense being desirable at once in cost of production at the station, in the motor,

and in the consumption by the motor of power.

But it is also necessary that the system be easy to work and direct, and moreover absolutely beyond the possibility of sudden interruption from accident. (In Paris, compressed air without interruption during 13 years.)

It is also necessary that the system proposed should be easily understood by any tramway operator, and that it should not be necessary to preface its consideration by long special technical study.

In the present state of the art of mechanical traction as applied to tramways, it is evident that if economical operation be desired, the supply of power from a central station is indispensable.

Operation by electric conductors carries with it many difficulties for the operator, largely arising from the inevitable complications of a service requiring such special knowledge as to make an expert technical staff in constant surveillance a necessity.

With compressed air the method of operation is so simple that there is no necessity for long study of an expert nature before undertaking the handling of that system, while it is at the same time so regular and sure that one is not kept constantly on the alert as is the case with the electric line.

It follows that the manager of a compressed air tramway can really direct its operation without being always at the discretion of an engineering staff, since he is free from apprehension of any serious trouble in his service.

To handle an air compressor is as simple as a pump. Any ordinary mechanic can undertake its management.

The air being stored in advance in great quantities at a time in the reservoirs of the central station—in the distributing pipes, and in the tanks of the motor—interruption of service is practically impossible.

One of the most important advantages of compressed air is that it lends itself so well—incomparably better than any other system—to direct storage, which quality admits of holding in reserve great accumulations of energy with so much ease and economy. So far as accumulation of reserve power is concerned, electricity has incontestibly shown itself greatly inferior to compressed air.

Automobile Compressed Air Fire Engine.

The time is comparatively near at hand when every city will have its public supply of air power, and when such a time arrives the utilization of compressed air will enter into almost every nook and corner of industrial, municipal and domestic enterprise. Its usefulness is so comprehensive that a central compressed air power plant might in these days look for a large and prosperous patronage.

One of the most forcible arguments for introducing a public supply of compressed air will be the degree of economy and the vastly increased protection which would be afforded by compressed air in the matter of fires. It is entirely feasible to propel a fire engine to a fire without horses and when it reaches the water supply to be operated by compressed air.

Protection against fires is one of the most important municipal questions, and the expense to the public of handling a modern fire department is one that requires skillful financial treatment to keep it within bounds and at the same time have an efficient department.

A public supply of compressed air would certainly reduce the expense of a fire department to within a reasonable figure, and the proposition to introduce automobile compressed air fire engines will in time bring forth potent reasons for the adoption of this system. The installation of a compressed air supply would not have to be borne by the fire department, because private enterprise will be glad to install central compressed air power plants, relying on the patronage of the general public in the matter of power, but when the advantage of such a system is well known any proposition to lay pipes in the streets for this purpose will receive the moral support of every fire board and a majority of the citizens, all of whom are interested in fire protection.

The plan to be followed is similar to that followed by the installation of gas and water plants. Mains would be laid in all streets, and air hydrants would be close to the water hydrants.

An automobile carriage with a suitable fire pump would constitute a fire engine, to be propelled by compressed air, electricity, gasoline or other motive power. With such an apparatus, the time used in reaching a fire would be reduced to a

minimum and the operation of applying the air power for pumping the water would take but a few seconds.

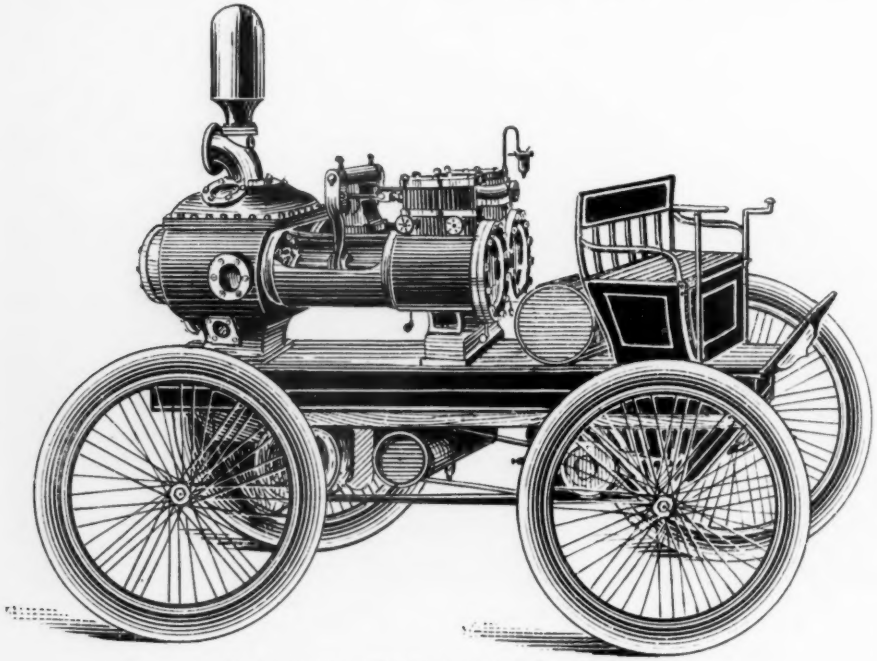
The advantage of this system, which does away with cumbersome boilers and dangerous progress through crowded streets with wildly excited horses, will be apparent to every one. If necessary a speed of 30 miles an hour may be obtained in going to a fire and without any undue commotion. The weight of the vehicle itself would be very much reduced. An ordinary engine to be drawn by horses weighs about 8,500 lbs. and an equally efficient automobile engine will not weigh more than 5,000 lbs. or possibly less.

As an illustration of possible economy in a city, we will give the statistics of the fire department of Newark, N. J.

The manual force of this department is 202 men with the following apparatus: Fourteen steam fire engines, 4 hook and ladder trucks, 1 aerial truck, 1 chemical engine, 4 engineer's wagons, 2 wagons for superintendent of fire alarm telegraph. In reserve are two steam fire engines, one hook and ladder truck, one chemical engine and one engineer's wagon; and the cost of operating the department for one year is $251,000. Eighty-two horses are kept in this department, aggregating the value of upwards of $30,000, and the mortality among horses in fire departments is necessarily high; consequently there is a constant expense from this cause.

Automobile fire engines should not cost more than ordinary fire engines. The number of men employed for taking care of horses would be dispensed with. No coal or other fuel need be used.

The item of keeping the above number of horses would amount to $19,680 a year, countng the expense of keeping one horse at $20 per month. The total saving in a department of the size of Newark, N. J., would probably reach $30,000 a year, or about 7½ per cent. of the total cost of running the department.



AN AUTOMOBILE COMPRESSED AIR FIRE ENGINE.

In the foregoing estimate no account is taken of the cost to the department for the use of the compressed air for operating engines which would be used during fires, and the reason for omitting it is because any company putting in a compressed air plant would readily concede the free use of power for such purposes in part compensation for the franchise privileges. But even if it had to be paid for at regular rates the cost would not amount to much.

The development of such a scheme is within practical limits and it only needs discussion and intelligent demonstration.

The automobile fire engine shown herewith is simply the combination of an automotor with an ordinary pump mounted on it. It admits of any modification from the position of the pump, which may be vertical instead of horizontal, and the construction of the carriage, which may be propelled by any reliable power, preferably compressed air.

Miscellaneous Applications of Compressed Air

Pneumatic Caissons for Ordinary Foundations.

At many places on our larger rivers it is so difficult to get first-class foundations, and keep other than first-class ones after once put in, that the only really safe way is to employ pneumatic caissons. For the ordinary large highway bridge as built by county or city, this is seldom considered, owing to the fact that comparatively very few officials having charge of this work know anything of pneumatic foundations, and until recently such work has been too expensive for bridges of this class. Pneumatic work has been made much cheaper by competition and skillful handling, until for large highway bridges where good foundations are hard to get it is not only the best method, but almost as cheap as pile foundations. When the pneumatic caisson foundation is completed there is no question as to its stability, and no future expense for protection to hold it. A well built bridge on this foundation is for the use of generations to come, and, unlike many bridges on other foundations, will not need replacing before the present generation has passed away.

A recent experience with a bridge on the Scioto River is a good example of pneumatic work for highway bridges. In 1871 the County Commissioners of Ross County, Ohio, built a bridge across the Scioto River at the old ford at the foot of Main Street, Chillicothe.

It had been with great difficulty that all previous foundations for Scioto River bridges in Ross County had been put in by use of cofferdams, owing to the river gravel being very coarse and full of bowlders, and taking this into consideration it was decided to adopt the pneumatic foundations, as being the surest and safest plan, and certain to reach bed-rock no matter what might be encountered. A few days after bids were received, the contract was awarded to Willard & Cornwell to construct two masonry piers on pneumatic caisson foundations, with crib filled with concrete to within five feet of low water, according to plan shown. On August 12th work was begun on setting up the air-compressor and getting ready for caisson No. 1. The contractors' plant for this work consisted of a double compressor with cylinders 14x16x18 inches, run by a boiler of locomotive type capable of generating 120 horse-power; a 115-volt dynamo of nine amperes capacity, run by a vertical engine supplied with steam from the big boiler; an air receiver fifty-six inches in diameter and fifteen feet long, and all necessary pumps, pipes, connections, fittings, etc., with hoisting engines, derricks, mortar boxes, tools and everything necessary for heavy masonry and concrete work. The compressor and boiler were set up on the solid roadbed, a few feet west of the old abutment, the compressor being next to the abutment, the boiler immediately west, and the dynamo and engine, for generating electricity for lighting the caisson, engine-house and office being in the same building and just south of the compressor and boiler, the whole being covered by a substantial frame shed 18x36 feet. An office, 10x12 feet, adjoins this building on the east. The receiver was placed north of the compressor, on the edge of the fill. A driven well at the foot of the embankment on this side, with a force pump, supplies water for the boiler and drinking

water for the men. An eight-inch natural gas main runs within 1,000 feet of the engine house, and an inch pipe was laid from it and connected to the boiler to supply fuel for generating steam.

Both caissons were built exactly according to plan, twelve feet wide by thirty-two feet long and six feet deep inside, and sheeted inside and out with two-inch plank. The sides and roof of the caisson are two feet thick, built of 12x12-inch timber, each course being fastened to the courses below with ¾ and ⅞-inch drift bolts, thirty inches long and placed four or five feet apart. The two courses of the sides and ends are firmly fastened together by two rows of ⅞-inch bolts extending clear through both. The two bottom layers of timber are beveled off on the inside until only about four inches wide at the bottom, and on the bottom a 2x6-inch plank is firmly spiked, forming the "cutting edge" of the caisson. Two 12x12-inch tie-beams are dovetailed into the sides of the caisson, thus dividing the inside into three equal "pockets." There are five holes through the roof, a four-inch hole at the centre of each end "pocket" for the blow-out pipes; in the middle pocket an 18-inch hole near one beam and a 20-inch hole near the other beam for the supply pipe and air shaft, respectively, with a 4-inch hole near the latter for the air supply pipe. When one course of the roof is placed, the shafts are fastened on by means of bolts through this course and the flanges of the shafts. The air shaft is thirty-six inches in diameter, of the best ¼-inch boiler iron, thoroughly riveted together at the lap joints and to inside flanges of 1½-inch cast iron at each end, each flange having twenty-eight ¾-inch holes for bolts to fasten joints together. The flanges are on the inside, so they can be used for the lock doors to fit against, and the bolts being on the inside can be removed and the top sections of the pipe taken out when pneumatic work is finished. The supply pipe is eighteen inches in diameter, of the same material as the air shaft, and 3-16-inch thick. It is riveted together the same as the air shaft, except that the cast flange is on the outside and has but eighteen holes for bolts. These shafts are in joints varying from nine to fifteen feet in length. The timber used in caisson walls in crib and outside sheeting may be any good round timber in lengths of ten to twenty-four feet. In this work hickory, lynn, sycamore, red oak, etc., were used for all work except inside sheeting, which was of dressed pine. The inside of the caisson, from the cutting edge to the roof, and all over the roof, was calked carefully in each joint between the timbers and around all bolt heads, then sheeted from bevel edge to roof and overhead, every joint of the sheeting being thoroughly calked. Caisson No. 1, which was to go in the middle of the river, was built on timber runways on the bank, arranged so they could be raised at one end and slide the caisson off into the water when it should be ready to launch. Two heavy ropes were placed around the caisson and tied to posts behind, the runways were covered with soft soap, and the ends raised until the caisson was started and held only by the ropes, which were cut simultaneously, and the caisson slid out into deep water and floated with the top but little above the surface. On September 8th it was launched, towed into position, and anchored by ropes leading to some old piles at one side, and to a heavy anchor and a piece of old bridge iron up stream. When launched, but one course of roof or decking had been put on, and as soon as anchored to place the other course was put on and the crib on top built up several feet. This cribbing is of 12x12-inch timbers, laid so as to make the outside of crib twelve feet by thirty-two feet, every other course tied together by two 12x12-inch cross ties dovetailed in, and the whole fastened together with thirty-inch drift bolts every four or five feet. The sheeting is also carried up continuous on the outside from the cutting edge. The top of the decking was then thoroughly grouted, the crib filled with concrete to the height of several feet, until the "cutting edge" rested on the river bottom and the top was four or five feet above water. This concrete was composed of one part Portland cement, two and one-half parts sand, and five parts gravel, with a good many large bowlders bedded in each layer. A three-inch pipe was laid from the receiver down the bank and along the river bed to the pier, and connected to the air supply pipe by a double flexible pipe joint. At noon of September 12th air was turned on and the work of sinking was carried on day and night by two crews, each working ten hours. Each crew of "sand hogs," as the men engaged

in this work are called, consists of a foreman, two blow-pipe feeders, four shovelers, an inside lock-tender and an outside lock-tender. The working chamber is lighted with three sixteen-candle power electric lights, and there is one in each section of the air shaft. The blow-out pipes just below the roof of the caisson

CAISSON NO. 3 BLOWING SAND.

are fitted with large valves with a four-inch opening. A piece of pipe from the valve extends to the bottom of the caisson, and when the valve is opened all sand, gravel and rock less than four inches in diameter brought up to the end

of the pipe is forced out by the air pressure. On the top of each blow-out pipe is fastened a "goose neck," a curved joint to turn the material away from the crib. This "goose neck" is cast iron, with a four-inch opening and heavy walls, especially on the upper side where the gravel strikes, for it comes out with such force that an ordinary pipe bent to a curve would last but a few hours. All rock too large to blow out through the pipes is "locked" out through the air shaft in sacks. To sink the caisson all material is cleaned out level with the "cutting edge,"

then it is "ditched" by shoveling several inches of material from under the "cutting edge" and given a "blow" by opening one of the valves and letting out the greater part of the air. Relieved of the lift of the compressed air, and with the weight of concrete on top, the caisson settles down from six to ten inches, or until the cutting edge is again on solid gravel. While the air is escaping the working chamber is filling with water, and will frequently be two-thirds full when done "blowing." Caisson No. 1, for eighteen or twenty feet below the bed of the river, went down smoothly and rapidly without delay. At this depth was encountered a layer of bowlders varying in weight from five pounds to over one hundred pounds, and at the bottom of the layer were three coping stones from the top of the old east pier, which had been washed out. These stones were thirty feet below low water and sixty-six feet from where the pier had stood, showing how deep the scour had been when the water was highest. As the water fell and the current became less swift, the larger rock coming down were deposited, and then the smaller rock, gravel and sand. This layer of rock was what had stopped the sounding rod, but immediately below was six or eight feet of quicksand, and then another layer of gravel and rocks, but bed rock was not struck until forty-three feet below low water. The bed rock consisted of black shale and limestone in alternating layers of about two inches in thickness. The caisson was landed and rock leveled down after twenty-three days' work, and on the morning of October 6th concreting the air chamber was begun. To concrete the air chamber a two-inch pipe connection is made from the air pipe to a point just below the top flange of the supply pipe. This pipe has a valve, No. 1, near the air pipe, and another valve, No. 2, on a T between valve No. 1 and the supply shaft. A top door opening down is then put on the supply shaft and the fastening taken off the lower door. A batch of concrete is shoveled into the supply pipe, the upper door pulled up, valve No. 2 closed and No. 1 opened. This puts compressed air in the supply shaft and allows the lower door to equalize open and the concrete falls into the working chamber, where it is rammed under the bevel edges and over the bottom by the "sand hogs." The lower door is then shut, valve No. 1 closed and No. 2 opened, allowing the compressed air in the supply shaft to equalize out and the top door opens. The process is repeated until the chamber is filled with concrete and barely a narrow passageway for one man is left between the lower doors of the supply shaft and air shaft. The lower doors are then shut, and the last man equalizes out. A regular air pressure is then kept on for twelve or eighteen hours, until the concrete sets. The air is then turned off, and the shafts filled with concrete as quickly as possible. As soon as the air pressure is taken off the lower doors drop and the space left in the working chamber is also filled with concrete, which runs in from the shafts. This finishes the foundation from bed rock to above low water.

Caisson No. 2 was built about ten feet back of the washed-out abutment, part of the old approach being leveled down to near low water mark so it could built exactly where it was to sink, and at noon of the 14th day of October air was put on caisson No. 2. This caisson was above the water level, and before putting on air it had been sunk about two feet. As the pressure at first would be low, temporary blow-pipes were put in the side near the roof, and used to blow out sand and gravel until they were down to water level. This required less air to blow out material than to lift it through the roof. When down to water level these pipes were removed and the holes plugged. This caisson went down without special incident until the "cutting edge" was about fifteen feet below low water, when a good sized red oak tree was encountered. Several blasts were put into holes bored in the tree under the cutting edge, until the trunk was severed at this point. The tree was then sawed up and removed through the air locks. Dynamite was used to blast out this tree, and also to blast to pieces large stone found in the caissons. When blasting the men stayed in the air shaft, and frequently in the working chamber itself, for the concussion from a blast is not felt under air pressure as it would be on the outside. Test rods were driven at several points inside, and there was apparently a level bed rock about twenty feet below low water. Accordingly on October 8th the cutting edge being about five feet from

the bottom of the rods, the first footing course was laid, and the next day the second course offset six inches all around, making it 11x31 feet. According to the rods we were then about two and one-half feet from bed rock. The "sand hogs" now attempted to pull the 7/8-inch sounding rods which had been cut off as the caisson was sunk, and found they could not move them, although but two and one-half feet were in the ground. They even broke a large chain by using lever-

Flashlight in Caisson.

age to pull on the rods—we then had them dig down at one point, and they brought up a sample of a peculiar material that was neither peat nor lignite, although it was evidently the bottom of an old swamp. The material was tough and like rubber when a pointed rod was driven into it, but a piece taken out proved to be brittle and of no strength. We now drove rods through it and found that after two or three feet they again drove part of the way, with great ease, until striking bed rock on a level with bed rock under caisson No. 1. It was decided not to land the caisson on the lignitic peat, as there was evidently quicksand under this layer, and the sinking was continued. This material was hard to work, and the "sand hogs" were seven days making two feet in depth. The first course of stone, and part of the second, was below water before it was decided to continue, and therefore the 11x31 feet of masonry had to be brought on up. A great many difficulties were encountered in sinking this last twenty-two feet, and it was not completed until November 30th. The compressor broke down twice, and high water got above the masonry and stopped the work once for several days. The first footing course dragged considerable and held back the caisson in sinking, and the ends at different times

were as much as a foot out of level. In bringing the pier back to a level several of the joints in the masonry were opened, but no stone cracked. Below this lignitic peat the sand and gravel was of a different character than that above, or what was encountered in sinking caisson No. 1. First there was eight or ten feet of sand almost as fine as quicksand, and working like quicksand, then the rest was coarse gravel with bowlders. This sand and gravel was dark, but contained but little soil, the color being given by hornblende and other dark rock in the drift. Within a foot of the bed rock was found a skull, which proved to be that of a pre-glacial hog. The lignitic peat is a formation of the glacial period.

Pier No. 3 was to be erected 154 feet east of the river, to hold the end of an approach span which was to take the place of that much embankment. One of the spans of the old bridge was repaired for this approach, and it was originally intended to use four-foot tubes sunk to solid foundation to hold the east end, but when bids were received the bid of $2,900 was made for a pneumatic caisson sunk to twenty feet below low water, with masonry pier. The bids for the tubes were from $1,012 to $2,200, and the Commissioners at first awarded the contract to the lowest bidder on tubes, but within three weeks the sinking of caisson No. 2 proved what difficulties might be encountered in sinking tubes and possibly result in failure, and the bidder on tubes willingly consenting, the contract for pneumatic caisson was awarded to the contractor who was building the other two. This caisson was built ten feet four inches by twenty-seven feet four inches on the outside, with walls of 10 x 12-inch timbers, making the inside twenty-three feet eight inches by six feet eight inches. Temporary blow-pipes near the roof were also used in sinking caisson No. 3, this time being placed in the ends. On December 12th air was turned on No. 3, and it was sunk through a layer of drift gravel, a layer of loose rocks, and a layer of quicksand, and landed on the lignitic peat nineteen feet below low water, and the concreting was completed on December 28th. High water delayed work on this caisson four days, breaking the air pipe in the middle of the river. This completed the pneumatic work, and the masonry, having been kept up pretty closely, was completed on January 6, 1899. All masonry work was of heavy freestone rock from Otway, near the Ohio River, in Scioto County. Three thicknesses, seventeen inches, twenty-one inches, and twenty-eight inches, were used. The masonry was quarry-faced, with full dressed beds and laid in Portland cement mortar mixed in proportion of one part cement to two parts sand. No grouting was used except in holes too small to ram concrete in, the backing being of stone placed far enough apart to allow concrete to be rammed in solidly between. Piers No. 1 and No. 2 are shown in the plan while pier No. 3 was lighter, being but twenty-four feet long by five feet three inches wide under the coping, and built with square ends. It being in place of an abutment, the earth fill is given a natural slope at the ends and in front of the masonry.

Many persons were allowed to go down in the caissons to see the process of working. For the trip they were fitted out with overalls, jacket, an old hat and rubber boots. The top door of the air-lock or shaft had a rope fastened in the ring to handle it by when the air was off. When the door was closed and the air pressure on several tons would be required to open it by force, but as soon as the signal was given—five taps with the hammer by the outside lock-tender—and answered by the tender inside, the valve would be opened and the air allowed to escape, the door at the bottom having

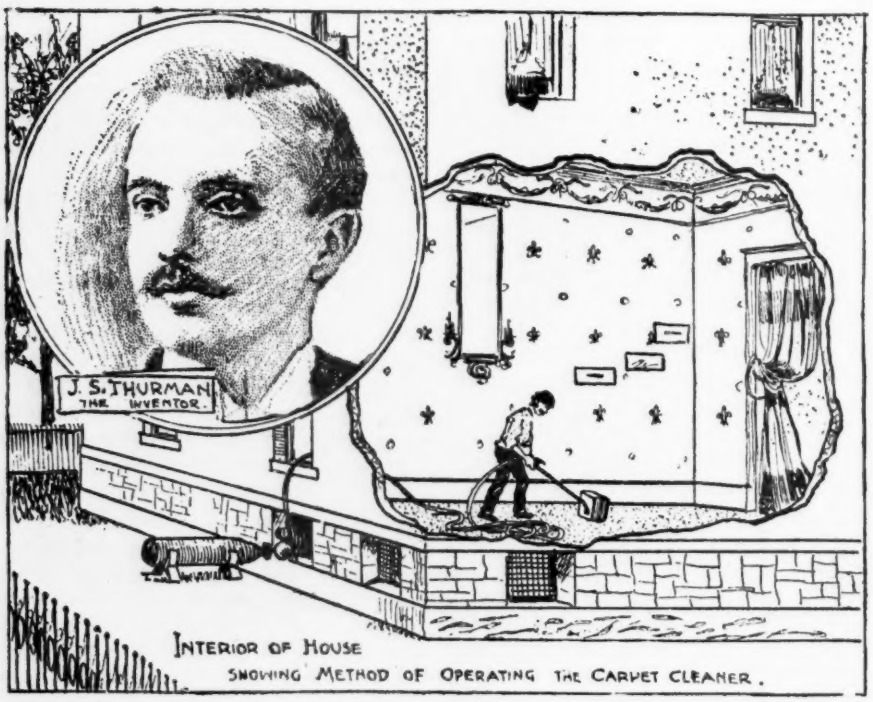
been previously closed, and when the air pressure was all off the top door would drop. The lock or shaft is a dark, forbidding-looking place, full of a fog which soon clears out, disclosing an iron ladder down one side and electric lamps for light. After going in, the top door is pulled up by the outside tender, and the pressure pipe opened. As soon as the pressure becomes considerable, the novice becomes "plugged," owing to the pressure on the ear drums pressing them in, but by holding the nose with thumb and finger, and with the mouth closed, a hard blow from the lungs, with distended cheeks, presses them out again, and relief is had. This can also be overcome by placing the ears close to the outlet pipe and opening the valve. When the pressure in the lock has become equal to that in the working chamber, the lower door drops, and the caisson can be entered. Owing to the excitement and the thought of what might happen, the perspiration comes easy, but the temperature is very little higher than outside. The blow-out pipes extend to the bottom of the end pockets, and when opened the sand and gravel rush to the end of the pipe like tacks to a magnet. Some air escapes with the gravel, the air becomes foggy, and the water comes in to a depth of six inches, or more; then the blow-out is closed until the air clears, and the water is driven out. The end of the supply pipe is curved and provided with a flap valve, which would close at once in case the supply pipe across the river broke, or the air was shut off in any way.

To sink the caisson the "sand hogs" dig out under the cutting edge, which process is called ditching, then the air is allowed to partially escape, and the caisson sinks or drops down. The chamber becomes foggy and half fills with water, but when the compressed air comes in strong again it clears up and the water is expelled.

The bid in detail upon which this work was awarded is as follows: For pneumatic caisson and crib filled with Portland cement concrete, on a basis of thirty feet or less below low water for pier No. 1, and twenty-four feet for pier No. 2, top of both cribs to be five feet below low water, $8,300; for rock, slate, logs, or bridge iron removed through locks, $9 per cubic yard; for excavation in slate or bed rock requiring blasting, $7 per cubic yard; for extra depth to forty feet below low water, $150 per lineal foot; for extra depth forty to sixty feet below low water, $160 per lineal foot; pier masonry, $7.25 per cubic yard. This was $12.77 per cubic yard of caisson and crib, not including rock, etc., that might be locked out, and $10.16 per cubic yard for extra depth to forty feet below low water. For pier No. 3 caisson and crib sunk to twenty feet below low water and filled with Louisville cement concrete, $1,600; for all material locked out, $193; for abutment masonry, $6.75 per cubic yard. This is $11,47 per cubic yard of caisson and crib, including all locked out material. Pier No. 1 was sunk 13.15 feet extra depth, and No. 2 18.68 feet extra depth, costing $4,832.80. Twenty-five cubic yards of rock was locked out of No. 1, and eighty-two cubic yards out of No. 2, at a total cost of $988.20, making Pier 1 and Pier 2 within five feet of low water cost $14,121, or $12.61 per cubic yard. The total amount of masonry in piers No. 1 and No. 2 above the level of five feet below low water, 498.73 cubic yards, and cost $3,615.79, or a total of $17,736.79, or an average for two piers entire of $10.95 per cubic yard. The contractors obtained most of their material and labor at very reasonable prices. For timber $11 per 1,000 feet B. M.; for sand, gravel and bowlders, 25 cents per yard; for stone, $3.35 per cubic yard, delivered at bridge site; for Portland cement, $2.15 per bar-

rel, all delivered at bridge site. Ordinary labor was $1.25 per day; the cost of other labor was from $1.50 to $2.00 per day, except stone-cutters, who received 25 cents per hour; foremen received from $2 to $5 per day.

We have adapted the above from an article published in Bridges and framed Structures by A. W. Jones.



INTERIOR OF HOUSE
SHOWING METHOD OF OPERATING THE CARPET CLEANER.

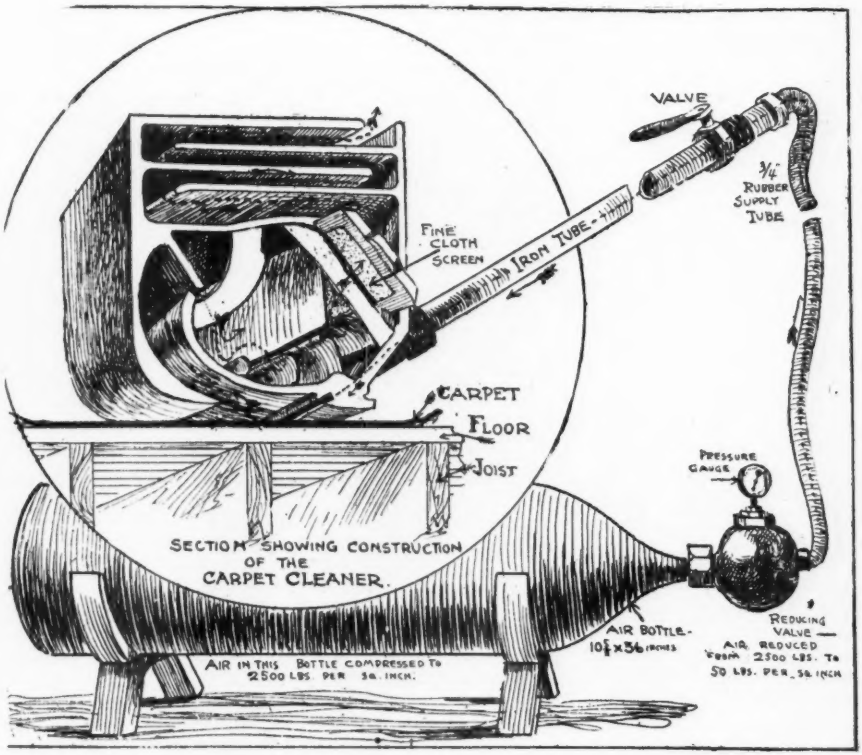
Pneumatic Carpet Renovator.

In a previous number of "Compressed Air" we called attention to an invention for cleaning carpets and we herewith illustrate the article itself and the method of operating it.

This carpet renovator, which was recently designed and patented by J. S. Thurman, formerly M. E. of the Mo. Pac. Ry. system at St. Louis, Mo., consists of a box or receptacle into which a blast of air is injected in the shape of a fan. The blast of air striking the carpet throws the dust through the tortuous passage and deposits the dust on the inside of the box; that dust, which is lighter than air, is caught by a screen before the air is exhausted into the room. The dust collector is about 8 in. long by 5 in. wide by about 6 in. high, and the blast of air is 1-64 in. wide by 8 in. long. This dust collector is pushed back and forth over the carpet by an operator and collects from 98 to 100 per cent. of all the dust that the carpet contains.

The source of air supply is obtained by compressing air into bottles or Mannesmann tubes at 2,500 lbs. pressure These bottles are filled with compressed air at a central plant, and equipped with machinery specially designed to compress air to a high pressure. On these bottles are attached a reducing valve to reduce the air from 2,500 lbs. to 50 lbs. per sq. in. The bottles, after being filled at a central plant, are delivered to the sidewalk in front of the residence to be cleaned. The hose is then connected to the reducing valve on the bottle and the other end of the hose taken into the house and the dust collector is attached. The dust collector is then run once over the carpets, which is sufficient to cleanse them of all dust and restore the carpet to its natural color. Before the carpets are cleaned the walls are cleaned and also the tapestries and cushions. It requires only about two hours to clean a nine-room house, and the charge will be nominal.

By the present method carpets are taken up and removed to a cleaning establishment, which requires three to four days, while with compressed air the work is accomplished in a far better and more satisfactory manner in two hours. In other words, the husband leaves home in the morning and when he returns in the evening the home is cleaned.


VALVE
¼" RUBBER SUPPLY TUBE
FINE CLOTH SCREEN
IRON TUBE
CARPET
FLOOR
JOIST
PRESSURE GAUGE
SECTION SHOWING CONSTRUCTION OF THE CARPET CLEANER.
AIR BOTTLE- 10½ x 36 INCHES
REDUCING VALVE
AIR REDUCED FROM 2500 LBS. TO 50 LBS. PER SQ. INCH
AIR IN THIS BOTTLE COMPRESSED TO 2500 LBS. PER SQ. INCH.

Liquid Air

Brief History of Liquid Air.

As the subject of liquid air and low temperature is receiving so large an amount of attention and thought in the scientific world to-day, a brief history of its production may be considered timely. Prior to 1877 air was thought to be a permanent or incondensable gas, but it was liquefied simultaneously by Messrs. Pictet and Cailletet at that time though at an enormous expense. About 200 years ago the lowest temperature thought to be obtainable was produced by a mixture of snow and ice and was used by Fahrenheit in establishing a zero for his thermometric scale. Since that time scientists have reached a temperature some 400 degrees below the lowest point ever reached by Fahrenheit. Of the three known methods for producing cold, the first, i. e. by the rapid solution of a solid, was used entirely up to 1820 and yielded a temperature of 50 degrees below zero centigrade. The other two methods are the rapid evaporation of a volatile liquid and the rapid expansion of a cooled and compressed gas. By a combination of pressure and refrigeration, Faraday in 1823 liquefied all except six of the existing gases, but it was not until 1869 that it was discovered that these gases must first be cooled to a critical temperature. By subjecting hydrogen to an enormous pressure and at the same time lowering its temperature it was found possible to liquefy it. Hydrogen has a critical temperature only 33 degrees c. above the absolute zero of temperature. From the experiments performed, the conclusion was drawn that solids, liquids and gases were but different forms of matter through which any substance could be made to pass by the addition or withdrawal of heat and pressure. The liquefaction of air economically and in large quantity has only recently been accomplished.—The Engineer.

Liquid Air as an Explosive.

Experiments which have just been made in Austria with liquid air as an explosive are reported to have brought forth sensational results. The liquid air was mixed with a siliceous marl, making a substance which is unsusceptible to shock, and will only act under direct ignition. This gives it an important advantage over dynamite. One-twentieth of a pint of the mixture was placed in a crevice in a quarry two feet deep and ignited by electricity. The effect of the resulting explosion is reported to have been equal to the work of twenty times the same quantity of dynamite. Tests were also made with the liquid air as an explosive of heavy ordnance, which showed that the gun was not heated and that the explosive will considerably increase the range of projectiles.

Liquid Air in Gas Making.

In the "Chemische Industrie" Professor W. Hempel, of Dresden, has an article on the use in gasmaking of the mixture of half oxygen and half nitrogen, which is obtained by liquefying air in a Linde machine and allowing the liquid air to evaporate its nitrogen partly away. The half-and-half mixture can be made at a working cost of 4d. per thousand cubic feet by evaporating the remaining liquid, and it can be applied in two ways, for making oxygen producer gas and for making oxygen water gas. Both in producer gas and in water gas the great advantages of internal heating are secured; but in both cases there is too much nitrogen in the product, and the heating values are relatively low.

Producer Gas.

In making this gas, as used in regenerative heating, we pass air through glowing coke so as to form carbonic oxide and nitrogen. But if Linde 50 per cent. oxygen be used the results alter considerably, in the manner illustrated by the following

table, which refers to gas made from brown coal:

	Ordinary Producer Gas, Volumes=Percentages.	Oxygen Producer Gas. Volumes.	Oxygen Producer Gas. Percentages.
CO_2	3.4	3.4	6.1
Heavy hydrocarbons.	0.8	0.8	1.4
Oxygen	0.3	0.3	0.5
CO	25.4	25.4	45.9
CH_4	5.3	5.3	10.7
H	6.8	6.8	12.3
N	57.4	12.7	23.0
	99.4	54.7	99.9

These results are approximate, and would be affected by the nitrogen taken in along with the production of CO_2; but, on the other hand, the production of CO_2 would be diminished, on account of the higher temperatures which would be obtained in the producer. For manufacture of such a gas as that in the last column it is only necessary to use the 50 per cent. Linde oxygen in the producer.

Air Jets

The unwatering of the Volunteer (Michigan) mine by using air has proved that one-third submergence is not necessary to successful operation. The water still comes to surface through the columns with a submergence of less than 15 per cent. This plan of unwatering mines is an excellent one and will be practiced in future where the air can be conveniently obtained.

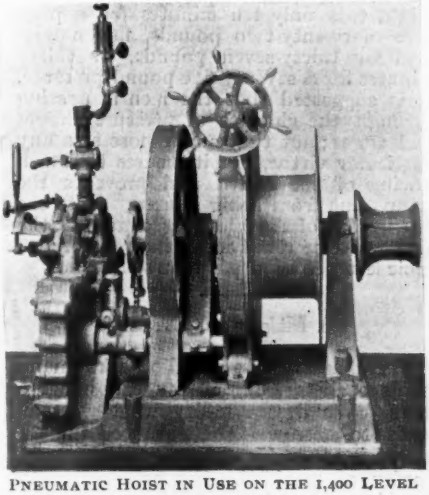
There will be no more Bourgogne horrors on passenger steamships, such as occurred last Fourth of July in the North Atlantic, when 600 lives were lost, if ex-Lieutenant J. W. Graydon can help it. He will also attempt to make impossible such terrible naval disasters as the sinking of the British battleship Victoria by collision in the Mediterranean a few years ago, when half a thousand lives were lost.

Lieut. Graydon has invented what he claims is a perfect safeguard against such catastrophes. It is a mechanism for closing the water-tight bulkheads throughout a ship instantaneously when an accident occurs.

No modern device has been more disappointing than the collision bulkheads on modern steamships. It always happens that at the critical moment when a disaster occurs, they are open. They cannot be closed in time, so the ship plunges to the bottom and the bulkheads prove useless.

The machinery necessary to do this would be simple enough. If compressed air were the power to be used, six to twelve storage tanks could be placed in the engine room. Pipes from these would lead to the cylinder and piston connected with every door. The opening of a valve by electricity would let the compressed air rush into the cylinder and force out the piston, which would push the sliding bulkhead door shut. An electric bell on the door would ring to give alarm to any one not to be caught in the vice-like grip of the closing steel door.

We present herewith the picture of a pneumatic hoist in use on the 1,400 level of the Gwin mine, Calaveras County, Cal. This hoist has a drum with capacity to carry several hundred feet of suitable rope. The drum is operated by a small hand-wheel fastened to the centre of the



PNEUMATIC HOIST IN USE ON THE 1,400 LEVEL OF THE GWIN MINE. CALAVERAS CO., COL.

shaft. The motor for operating this hoist consists of two Dake engines of the reciprocating type and is operated by compressed air. It is portable and made so that it can be readily run through a drift on a flat car.

A discussion took place recently at the International Mining Congress at Brussels as to the limits of safety to which work can be carried on under compressed air. The Austrian doctors declared that men under twenty and over fifty years of age should not be allowed to work where the air pressure was high, and in all cases medical certificates should be forthcoming as to the soundness of the heart, lungs, and the vascular system. An ear affection, a cold or gastric attack should be sufficient for prohibition. The limit of pressure should be seventy-five pounds, which would enable the work to be carried on under water at 170 feet from the surface, but in such cases special precautions would be necessary in returning from the high pressure to the normal condition. The minimum would be 100 minutes, but the men may continue to work for any period. It is one of the peculiarities of working under high air pressure that healthy men might almost live in the pressure chamber, but the change from high to lower pressure should take one minute for every one and one half pounds of pressure. Men accustomed to the work might take only ten minutes for a pressure of twenty-two pounds, fifteen minutes for thirty-seven pounds, or thirty minutes for a seventy-five-pound pressure. It is suggested that the men in passing through the changes of pressure should suck sugar; not that sugar possesses any particular virtue, but it insures the swallowing of the saliva and prevents the tympanum from being injured. As to the ventilation of the working chamber, the air should be renewed at the rate of 700 cubic feet per head per hour.—Ex.

A Midsummer Dream.

There are in this world of ours many ideals of higher life if you can imagine them. We dream to-day what we may realize to-morrow. The advanced thinker is consistent in his endeavor to lighten the burden of mankind. His principle is to provide every device necessary for the higher degree of personal comfort within in the desire of man. Within the range of compressed air applications there is as much hope as can be obtained from any other field of science.

When the many appliances that are possible have been invented and perfected, and when every house has its supply of compressed air then man enjoys the many luxuries that hitherto have not been available, and man, though perhaps no happier, will at least have less reason to complain.

THE FRONT DOOR.

With these philanthropic thoughts our friend of Dustiana approached a modern house on a noted boulevard of a strange land, and, although his appearance was out of the ordinary, the maid invited him to step inside

"And wait
While I inflate
The tete a tete."

She occupied but a moment in doing so and he found the parlor furniture all pneumatically stuffed. It consisted of chairs and couches, easy chairs, footrests, headrests and pillows. They were all collapsible. The radiator used in winter to radiate heat here radiated cold. The thermometer registered 98° outside, while it was 70° inside. A thermostat on the wall controlled the ventilation and temperature and the zephyrs caused by the tiny jet of escaping air reminded him of a familiar saying and was to him a new use of air—appreciated by many. He never knew that compressed air could be used for agitating whiskers.

He gently rocked himself in a luxurious arm chair and noticed the maid running the pneumatic carpet renovator over the floor, removing every particle of dust and gathering it up. He now knew that he was in the fabled land of Puritania.

While seated here the temperature fell to 69 degrees and the thermostat clicked, and the cold air current in the radiator was shut off by such operation at the same

THE COLLAPSIBLE PARLOR.

time it caused an automatic piano to begin playing that inspiring air: "There'll Be a Hot Time in the Old Town To-Night."

From the collapsible parlor he went to the kitchen—people of his craft being wont to patronize that part of the house more frequently than any other—there the cook had placed a kettle of liquid air upon a cake of ice and you need not wonder that he was astonished when he saw it boiling furiously.

THE KITCHEN IN PURITANIA.

Many of her duties were facilitated by the use of compressed air, and she beat several eggs by that process and made for him an omelette of exceedingly palatable flavor.

The meat and vegetables, fruit, milk and butter were preserved in a compressed air refrigerator.

He wandered along the hall and went upstairs. The bedrooms were furnished with air beds and pillows. The fuel that was burned was aerated. The walls wore a chastened look and the curtains were immaculate. Every morning they received an ablution of air. He looked out of the window and the gardener was guiding an air-driven lawn mower over the lawn.

In a lady's boudoir he found upon a dressing case a most ingenious article which proved to be an air brush. Ostensibly it was to be used for amateur sketching, in practical use it added delicate color to my lady's complexion.

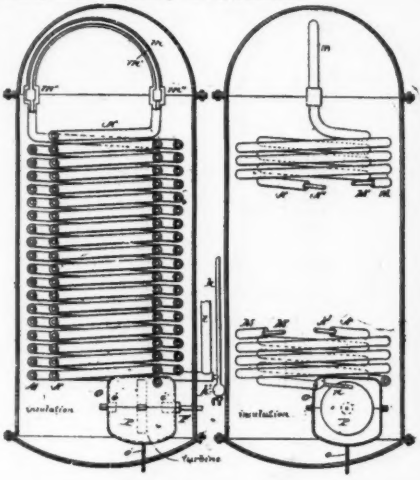
The pilgrim from Dustiana marveled much as he left this abode of rarefied delight and walked again into the realm of the heavy atmospheres of his native land.

PATENTS GRANTED JUNE, 1899.

Specially prepared for COMPRESSED AIR.

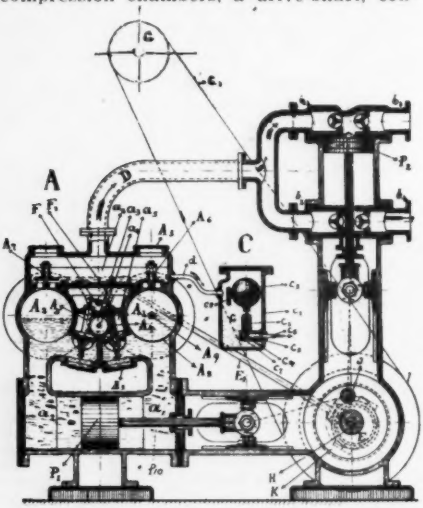
627,696.—Apparatus for Liquefying Gases. Joseph E. Johnson, Jr., Longdale, Va.

An air liquefying apparatus, in combination, a compressor, a cooler, an insulating vessel, a counter-current apparatus in said vessel, a liquid air receiver in said vessel, a discharge nozzle delivering compressed air from said counter-current apparatus into said receiver, an impulse wheel or turbine impelled by the discharge of air from said nozzle, and means connecting said wheel or turbine with a mechanical resistance, substantially as specified.



626,883—Air Compressing and Cooling Apparatus. Rudolph Berg, Pittsburg, Pa.

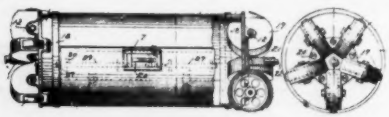
An air compressing and cooling apparatus, the combination of a compression-chamber and a piston operating therein, a series of heat absorbers mounted in said compression-chamber and adapted to cool the air during its compression; an expansion chamber and a piston operating therein; a pipe connecting said expansion and compression chambers, a drive-shaft, con-



nections between the piston of the expansion chamber and the piston of the compression chamber; an air chamber and a pair of suction valves controlling the inlet and outlet passages of said chamber, and a rod eccentrically connected at its one end to the drive-shaft and at its other end connected by levers to the suction valves whereby the same are alternately operated and in conjunction with the operating of the pistons in the compression and expansion chambers, substantially as described.

627,181.—Carrier for Pneumatic Dispatch Tubes. Edmond A. Fordyce, Chicago, Ill.

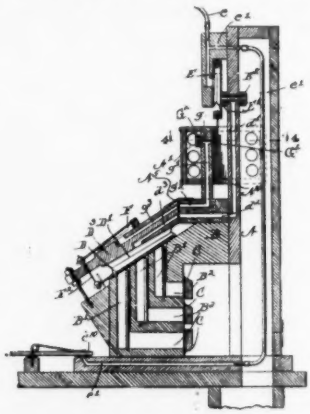
In a carrier adopted for transit in a dispatch tube, the combination with the body of the carrier of a series of guiding and supporting wheels mounted thereon at or



near each end, the wheels of the two series being so located and arranged relatively to each other that none of the wheels at one end will be in the same longitudinal plane as any of the wheels at the other end, as and for purposes described.

626,320.—Pneumatic Organ. Melville Clark, Chicago, Ill.

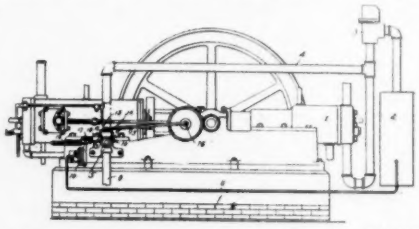
In a pneumatically-operated musical instrument in combination with the valve which controls the sounding devices; a motor pneumatic which operates such valve; a supplementary pneumatic adapted to operate the valve; a supplementary pneumatic adapted to operate the valve in the opposite direction from the motor-pneumatic; a primary pneumatic which controls



both the motor-pneumatic and the supplementary pneumatic; the valves which effect such control arranged to be actuated by each action of the primary pneumatic oppositely with respect to the motor and supplementary pneumatics which they respectively control; whereby the motor-pneumatic is rendered active when the supplementary pneumatic is rendered inactive, and the supplementary pneumatic is rendered inactive when the motor-pneumatic is active.

627,850.—Compression Controller. Frank G. Hobart, Beloit, Wis.

A compressor unloading device comprising an unloading valve, a ratchet handle secured thereto, a pawl designed to engage

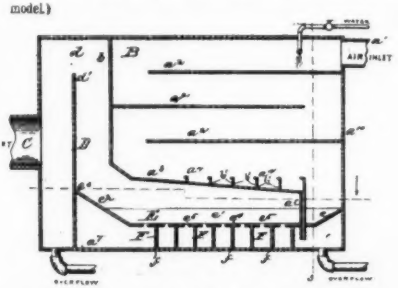


said ratchet handle, an eccentric pin rotated by the compressor whereby said pawl receives a reciprocating motion, and an automatic pressure operative device whereby said pawl is thrown into or out of action to open or close said unloading valve.

626,390.—Air Cooling and Cleansing Device. Joseph McCreery, Toledo, Ohio.

An air cleansing and cooling device, consisting of a case having an air inlet and a water inlet at the top, and an air outlet and a water outlet at the bottom, and a series of baffle-plates interposed between the inlets and outlets, the lowermost baffle-plate being inclined downwardly and having across its upper surface a series of rifles

(No model.)



increasing in height from top to the bottom, such rifles having perforations at their bottom, and their tops being spaced apart from the baffle-plates above them the same distance as the other baffle-plates are spaced apart, whereby the air passage through the baffle-plates is substantially the same size throughout as and for the purpose set forth.

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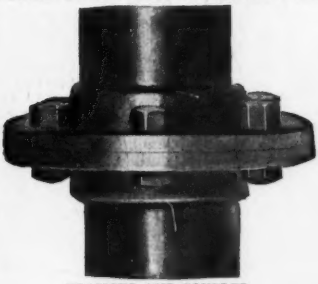

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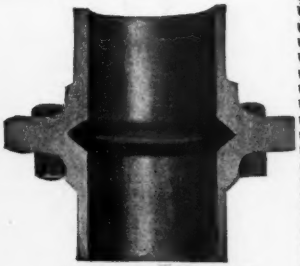

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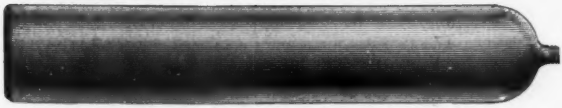

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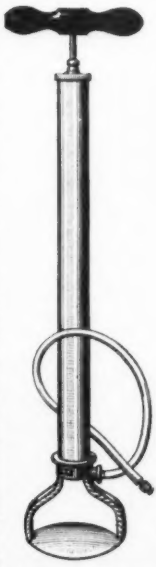

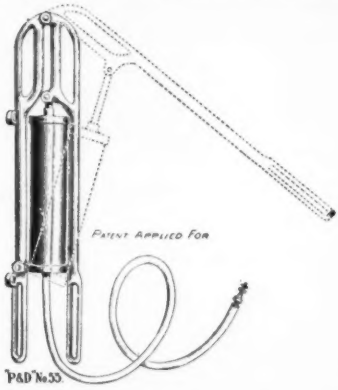

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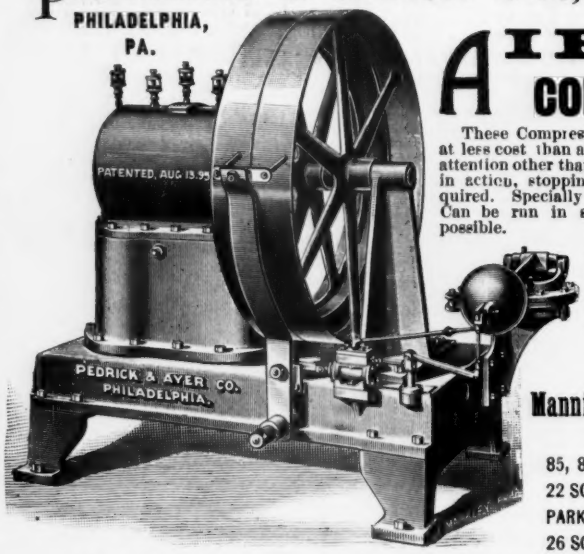

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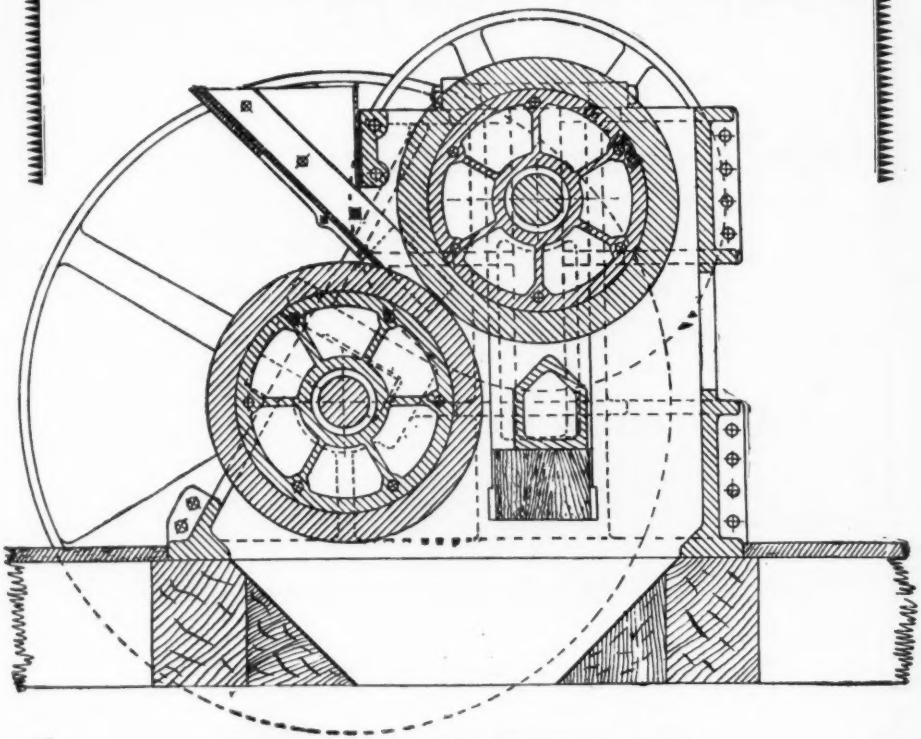

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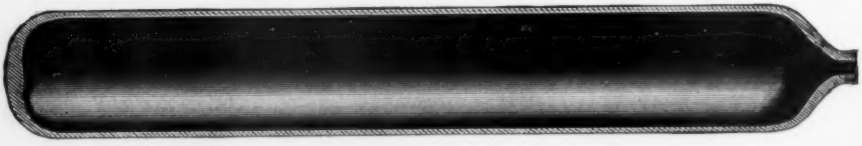

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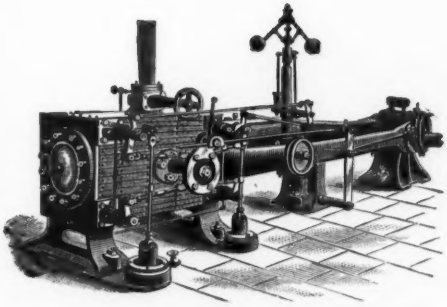

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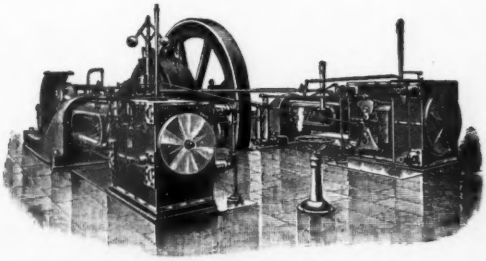

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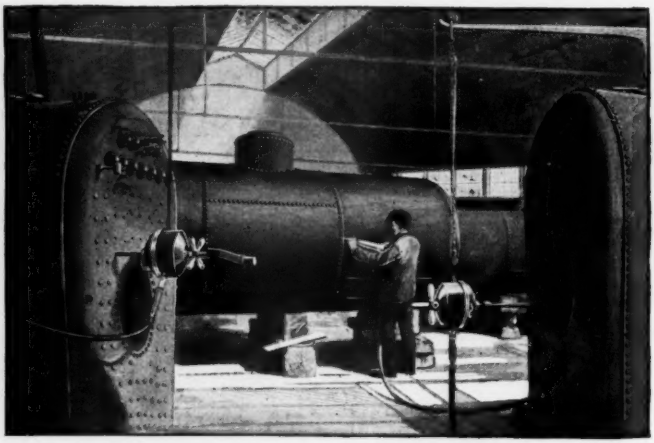

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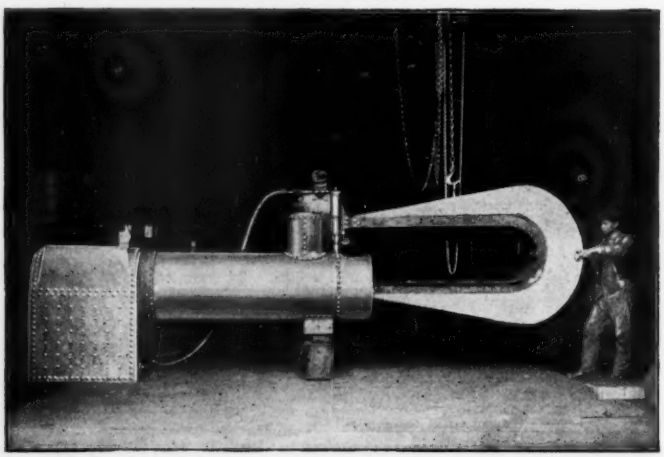

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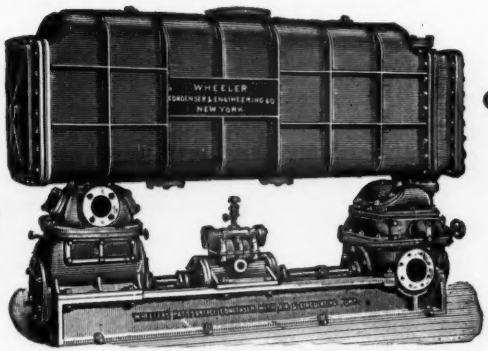

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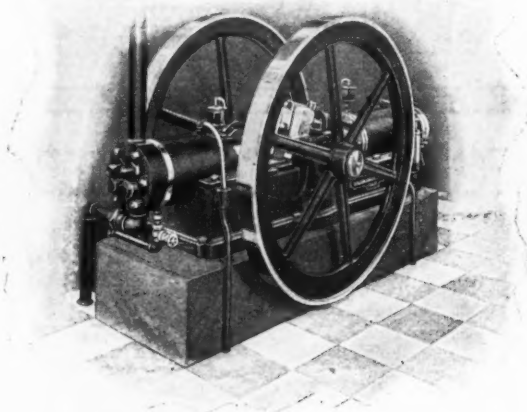

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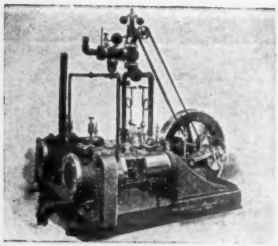

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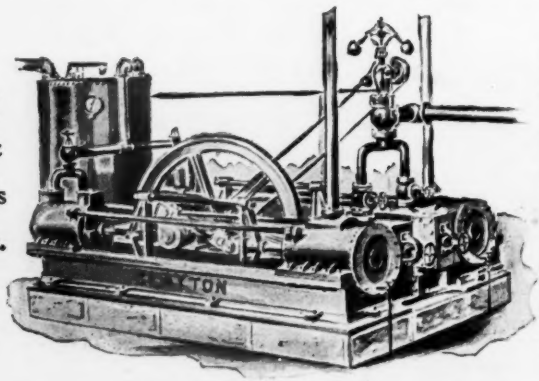

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